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GUIDELINES

FOR

ENVIRONMENTAL CONTROL

IN THE

ONTARIO MINERAL INDUSTRY

OCTOBER 1, 1981

Ontario

Ministry of the Environment

The Honourable
Andrew S. Brandt
Minister

Dr. Allan E. Dyer
Deputy Minister

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STATEMENT OF INTENT

The primary purpose of these guidelines is to assist Ministry staff in the execution of abatement and approvals functions. They may also be used by industry as an indication of environmental control requirements.

These guidelines are supplementary to the "Guidelines and Criteria for Water Quality Management in Ontario", the "Objectives for the Control of Industrial Wastes Discharges in Ontario", and the requirements of the Environmental Protection Act pertaining to the emission of air contaminants and the disposal of solid wastes. Details of Provincial noise control requirements are embodied in The Model Municipal Noise Control By-law and its supporting technical publications which contain acceptable noise level limits applicable to industrial activity.

> The guidelines reflect overall Ministry policy. They should be applied recognizing specific requirements of individual sites, alternate process and abatement technology, and the need to stage programs which will achieve the Ministry's goals in a rapid but realistic manner.

I N D E X

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EFFLUENT GUIDELINES

FOR

MINING OPERATIONS

IN THE

PROVINCE OF ONTARIO

1979

INTRODUCTION

The effluent guidelines presented in this document represent the minimum degree of treatment that should be applied at all active, inactive and abandoned mining operations in the Province of Ontario.

Specific effluent guidelines for individual contaminants will be defined by the Ontario Ministry of the Environment for a specific mining property or for a specific mining area should such action be warranted.

The effluent guidelines presented in this document are to be applied to the control point (or control points) designated by the Ontario Ministry of the Environment at any mining property.

EFFLUENT GUIDELINES

(1) 5-DAY BIOCHEMICAL OXYGEN DEMAND (BOD_5)

Unless otherwise specified by the Ontario Ministry of the Environment, the concentration of BOD_5 in wastewaters at the point of discharge should not exceed 15 milligrams per litre (mg/l) at any time.

(2) SUSPENDED SOLIDS

Unless otherwise indicated by the Ontario Ministry of the Environment, a mine-mill effluent should not contain more than 15 mg/litre of suspended solids.

(3) OILS AND GREASES; FLOATING MATERIALS

Unless otherwise indicated by the Ontario Ministry of the Environment, the concentration of oils and greases of vegetable, animal or mineral origin in wastewaters at the point of discharge should not exceed 15 mg/l.

All floating materials, other than those of natural origin, should be excluded from streams and lakes.

(4) METALS

The total concentration of any individual metal (excluding calcium, magnesium, potassium and sodium) in a mine-mill effluent should not exceed 1 milligram per litre (mg/litre) per metal unless otherwise indicated by the Ontario Ministry of the Environment.

In addition, the cumulative concentration of copper, lead, zinc and nickel in a mine-mill effluent should not exceed 1 mg/litre unless otherwise indicated by the Ontario Ministry of the Environment.

Also, as a goal, cadmium and mercury in mine-mill effluents should not be discharged in concentrations that are in excess of natural cadmium and mercury background concentrations.

(5) pH

The pH of a mine-mill effluent should be maintained within the range of 5.5 to 10.6 at all times unless

otherwise specified by the Ontario Ministry of the Environment. The pH should not be permitted to drop below 5.5. Sudden changes in pH should be avoided.

(6) AMMONIA

Unless otherwise specified by the Ontario Ministry of the Environment, the concentration of ammonia (NH_3 expressed as N) in effluent at a designated control point should not exceed 10 mg/litre.

In view of the known acute toxicity of ammonia to aquatic life, a more stringent effluent quality requirement may be applied consistent with the availability of practicable technology.

NOTE: With regard to the above guideline and in recognition of the safety aspects of ANFO explosives that find general use, minewater will be considered on a special basis. However, good housekeeping practices in the mine must be maximized and available waste treatment technology must be utilized to meet the guideline when and where practicable.

(7) PHOSPHORUS

Unless otherwise indicated by the Ontario Ministry of the Environment, a mine-mill effluent should not contain more than 1 mg/l total phosphorus. Mine-mill operations with discharges containing less than 10 lb/day total phosphorus are exempted from (7).

(8) ARSENIC

Unless otherwise indicated by the Ontario Ministry of the Environment, a mine-mill effluent should not contain more than 0.5 mg/l of arsenic. A more stringent guideline should be adopted as the availability of practicable technology permits.

(9) CYANIDE

NOTE: This (cyanide) guideline will come into effect on May 1, 1979.

Unless otherwise indicated by the Ontario Ministry of the Environment, a mine-mill effluent should not contain more than 2 mg/litre of cyanide (free and/or complexed) expressed as HCN.

This is an interim guideline. As the availability of practicable technology permits, cyanide discharges should be reduced to the lowest levels attainable.

(10) COLOUR

Mine-mill wastes that are discharged to a natural watercourse should be clear and colourless.

(11) SULPHATES AND TOTAL DISSOLVED SOLIDS

Sulphate and total dissolved solids loadings in mine-mill effluents should be kept as low as possible using the best available practicable technology.

(12) UNSTABLE CHEMICAL SPECIES

Unstable chemical species (for example: unstable sulphur compounds) should not be present in a mine-mill effluent in concentrations that cause adverse environmental effects in the receiving water.

(13) PHENOLS

Unless otherwise indicated by the Ontario Ministry of the Environment, a mine-mill effluent should not contain more than 20 ppb phenols.

ENVIRONMENTAL DESIGN CONSIDERATIONS

FOR

ONTARIO MINING OPERATIONS

1979

ENVIRONMENTAL DESIGN CONSIDERATIONS FOR ONTARIO MINING OPERATIONS

This section is intended to give guidance to those involved in the complete sequence of events surrounding a mining operation. The four titled areas of discussion have been devised to ensure that the proponent creates as little environmental degradation as possible during the life of the mine as well as after the operation has been abandoned. The points covered within the Exploration, Mine-Mill Development, Operation and Abandonment phases would not in themselves constitute an environmental assessment procedure. They are too site-specific in their context. An environmental assessment would come at a much earlier stage of development when a much broader range of topics and alternatives would be investigated and the option of not proceeding with the development was still available. However, an adherence to these environmental design parameters and construction procedures will help to make mining activities more compatible with the natural environment.

PART A: EXPLORATION

Exploration activities may be grouped under line cutting, the construction of temporary access roads, the location and construction of work camps, trenching etc., and diamond drilling.

A-1: Surface geophysical work generally necessitates the cutting of lines through the bush etc., in a grid pattern. Since these lines are generally of minimum width, only minor environmental problems should be encountered. Line cuts should be kept to minimum practical lengths and widths.

A-2: Temporary access roads should be constructed in a manner that minimizes the disturbances of local drainage patterns. In order to prevent unnecessary soil erosion and in order to maintain the natural appearance of the locale, bulldozing of standing timber should be kept to a practical minimum.

A-3: The use of pesticides, herbicides or defoliants to control biting insects or to remove vegetation should be avoided when possible. Questions concerning the use of these chemicals etc., should be referred to the Pesticides Control Section of the Ontario Ministry of the Environment.

A-4: Temporary work camps should be equipped with adequate facilities for the disposal of sanitary wastes. Camp garbage should be disposed of in a suitable manner. Camp garbage should not gain access to a watercourse and should not contribute to litter. When the camp is to be abandoned, all temporary buildings and debris should be removed, burned or buried as may be appropriate.

A-5: Exploration trenches and pits etc., should be backfilled when no further examination of exposed rock is required. Backfilled areas should be compacted and seeded in order to prevent erosion.

A-6: Diamond drilling operations are such that small quantities of oil and other lubricants etc., can be released to the environment. Facilities to trap and hold such waste substances should be provided when necessary. Subsequent disposal (burial etc.) of all waste substances should be provided for. Drill-site debris should be cleaned up when the drill site is abandoned.

PART B: MINE-MILL DEVELOPMENT

Mine-mill development activities may be grouped under:

- dewatering of all mineral workings for the purposes of mineral re-evaluation etc.
- the diversion of watercourses to permit mining etc.
- the location of fresh water supplies for use in mineral processing etc.
- the stripping and disposal of open pit overburden
- the location of sites for the proper disposal of waste rock and for the storage of ore and low-grade material
- the location of sites for and the construction of mine-mill buildings and all associated facilities
- the location of the sites for and the construction of adequate tailings disposal areas

- the selection of appropriate waste treatment methods for all wastes and the construction of all required facilities.

B-1: A mine operator should determine the natural background concentrations of all known or suspected contaminants of air, land and water for each new mining property. If possible, this information should be obtained before actual physical development of the property commences. Typical metals and/or substances of concern are noted in "Effluent Guidelines for Mining Operations in the Province of Ontario".

B-2: A mine operator should obtain a detailed chemical analysis of water found in abandoned mine workings before the workings (shafts, pits, large trenches etc.) are dewatered.

B-3: If underground mineral workings, pits, etc., are to be dewatered for any purpose, the resultant water must be acceptable for discharge to a natural watercourse. If the water that is to be pumped etc., from the workings is impaired in any sense, then physical and/or chemical treatment of the water must take place before the water is discharged. Any liquid wastes generated during the periods of exploration and/or development must be likewise treated before discharge to a natural watercourse.

B-4: Lakes, ponds, rivers, streams and, in general, natural watercourses should not be dammed, diverted from their natural courses or pumped dry in order to permit or to facilitate mining operations <u>unless approval for such a project has been obtained</u> from appropriate government agencies including:

(i) The Ontario Ministry of the Environment

(ii) The Ontario Ministry of Natural Resources.

B-5: If water in excess of 10,000 imperial gallons per day is to be taken for mine-mill etc., purposes, <u>approval must be obtained</u> from the Ontario Ministry of the Environment.

B-6: Ore that is to be developed by open pit methods is usually covered by a relatively thin layer (a few feet or a few tens of feet) of unconsolidated or consolidated material. If this material is solid

rock it may be used for road building etc. Unconsolidated material such as muskeg, clay, sand and/or gravel, although frequently treated as useless waste, should always be directed to its own dump site where temporary or permanent storage of the material can take place in a manner such that erosion is minimized. If, upon abandonment, no real use can be found for this material, it can be revegetated with a minimum effort. However, in nearly all cases, material of this nature can be used (for revegetation purposes) to cover badly despoiled areas, to cover large relatively flat barren areas, to bury garbage, to cover concrete pads after the (mill etc.) buildings have been removed, to cover parking lots, to cover unused roads and to revegetate benches in pits etc. The uses this type of material can be put to are almost unlimited.

B-7: With stripping ratios (waste/ore) of up to 5:1, the disposal of waste rock at some mining sites is a major problem. Each waste dump may contain hundreds of thousands or millions of tons of barren or sparsely mineralized waste rock.

a) Waste rock dumps should always be sited on a secure base (solid rock if practicable).

b) Waste rock dumps should be constructed in a location and manner that minimizes the leaching effects of natural precipitation.

c) Waste rock dumps should always be sited as far away as possible from natural watercourses etc. Where this is impossible, uncontaminated freshwater streams etc., should be diverted around or away from waste rock storage areas.

d) Waste rock containing abnormal concentrations of iron sulphides or other undesirable reactive materials should be disposed of in a separate rigidly controlled storage area. This type of material should not be used for general purposes such as the construction of tailings dams or roads etc.

e) Waste rock storage piles should not be permitted to become a major feature of the local landscape. In other words, the height of a waste rock dump should not be in excess of the local mature treetop level where this is practicable. Where this

is not practicable, common sense should be used.

This type of height restriction should also be placed on tailings dams.

B-8: All petrochemicals, bulk chemicals and miscellaneous chemicals required at a mine-mill operation should be stored in well defined areas that are enclosed by adequate impervious curbing in order to contain accidental spills. All storage tanks should be located on impervious concrete or rock pads. Each storage tank should be surrounded by a continuous impervious curb of sufficient height to contain 110 per cent of the capacity of the tank. Where a curb contains more than one tank, the emergency storage capacity required is equal to the capacity of the largest tank plus 10 per cent of the aggregate capacity of all the other tanks or 110 per cent of the largest tank, whichever is greater.

B-9: Mine-mill reagents vary in toxicity. Some are highly toxic while others, considering the circumstances of use, are relatively non-toxic. Some are persistent and hence will escape from a tailings area to downstream waters. Others are unstable and will break down in a tailings area.

When reagents are being chosen for use in a mining operation, the least toxic compounds available should be chosen whenever practicable. Included in the definition of "least" toxic compounds are those toxic compounds that break down rapidly (into innocuous substances) and those which can be removed easily from a waste stream using accepted waste treatment technology.

B-10: The use of mine-mill reagents that are persistent (that is, reagents that do not break down easily in a natural environment) should be avoided if practicable.

B-11: The use of mine-mill reagents having known or suspected nutrient properties should be avoided if practicable.

B-12: When choosing a reagent for use in a mine-mill circuit or process, the total effect of that particular reagent on the receiving watercourse should always be considered. Reagent characteristics to investigate, for instance, would generally include chemical oxygen demand, bio-chemical oxygen demand, biodegradability, effects on local aquatic life (plant

and animal) and effects on the total dissolved solids concentration and hardness of the receiving stream.

B-13: The use of mine-mill reagents that consist of or contain water-soluble salts of metals that are known or suspected to exhibit undesirable environmental effects should be avoided if practicable.

B-14: It is generally desirable to locate a tailings area decant as close as possible to the mill. Since waste treatment facilities will normally be located at or near a tailings area decant, a decant facility close to the mill will:

a) permit shorter hydro lines to the treatment site

b) permit shorter access roads to the site and will hence reduce road construction and maintenance costs

c) permit shorter recycle etc., lines from the site to the mill. Subsequent savings will be realized in pumping costs, insulation costs and so forth

d) in some cases permit waste treatment reagent storage tanks, mixing tanks etc., to be located in the mill itself. Under these circumstances, waste treatment reagents could be pumped directly to the treatment area thus eliminating the expense of a heated automatically controlled waste treatment building at the treatment site itself.

In addition to the above, a tailings area decant adjacent to the mill permits close surveillance of the tailings area effluent by the mill staff.

B-15: THE RECYCLE (RE-USE) OF MINE-MILL WASTEWATERS MUST BE PRACTICED TO THE MAXIMUM EXTENT PRACTICABLE AT EACH MINE-MILL OPERATION.

B-16: Wastewater recycle is most often complicated by the presence of mineral slimes and/or residual quantities of persistent reagents in the recycle stream. As a result, one or more circuits in the mill may not accept the recycle water. Therefore, wastewater recycle should generally not be attempted from the primary (tailings) pond itself. The tailings area decant should be directed to a secondary area which acts as the recycle intake point.

B-17: WHENEVER PRACTICABLE, LAND DISPOSAL OF TAILINGS SHOULD BE PRACTICED.

WHENEVER PRACTICABLE, UNDERWATER DISPOSAL OF TAILINGS SHOULD BE AVOIDED.

B-18: All standing timber and/or brush should be removed from a tailings area before the area is placed into operation.

B-19: Tailings area decant ponds must be sufficiently deep to provide a quiescent settling zone for the tailings particles. If the pond is too shallow, wind and wave action may prevent settling.

B-20: The water in a decant pond should not be allowed to come into direct contact with a tailings dam. Where water must directly contact a dam, the water depth should be minimal and protection against wave action should be provided.

B-21: Emergency wastewater capacity in a tailings area should be provided. This can be done by ensuring that the overflow structure on the decant tower etc., is adjustable.

B-22: Decant tunnels (within a tailings mass) should be kept as short as possible. Consideration should always be given to alternate decant facilities should the main structure fail.

B-23: The main functions of a tailings area are solids: liquid separation and solids containment. As a general rule, chemical and/or biological treatment of the liquid phase of a tailings slurry should not be attempted within the confines of the tailings area itself.

B-24: When practicable, tailings dams should be constructed to their final heights before milling commences. When practicable, all downstream slopes of tailings dams should be revegetated as quickly as possible.

B-25: The use of classified mill tailings for the construction of perimeter (external) tailings dams should be avoided if practicable.

B-26: Whenever and wherever practicable, tailings dams should be impermeable. Impermeable dams do not give rise to contaminated seepage flows.

B-27: All contaminated seepage flows from the bases of permeable dams should be collected for treatment.

B-28: All liquid waste flows originating at a mining operation should be monitored (chemical characteristics, volume etc.) by the company involved on a routine basis.

B-29: In general, seepage from the bases of permeable dams should not be returned directly to a tailings area.

B-30: The design of a tailings area, especially a tailings area that is to be incorporated into a wastewater recycle scheme, should not be finalized until the following factors have been taken into consideration:

(i) Many important mine-mill reagents are organic compounds. In a favourable environment, most of these compounds will exhibit a degree of biodegradability.

(ii) Residual concentrations of mine-mill reagents have been identified in the effluents from mining operations that work sulphide ores. For instance, xanthate residuals of 0.2 to 1.2 mg/litre and dithiophosphate residuals in the range of 0.3 to 2.7 mg/litre have been noted.

(iii) In general, the constituents of frothers are volatile substances. Accordingly, a substantial quantity of the frothers added in flotation operations is volatilized so that re-use of flotation tailings waters does not necessarily reduce proportionately the requirement for frothers.

Unwanted quantities of a particular frother appearing in a recycle stream (from a tailings area etc.) can probably be reduced or eliminated by:

a) increasing the retention time of the frother-containing wastes before recycle to the mill; or

b) applying a degree of mechanical aeration etc., to the frother-containing waste; or

c) selecting another frother with superior breakdown properties for use in the mill.

B-31: Tailings lines should be duplicated whenever and wherever practicable. The function of the second line is to provide an alternate tailings discharge route should the first line break, plug, freeze or require repairs.

B-32: In general, tailings lines should be as short as possible. The longer a tailings line is, the greater the chances of failure are. A short line is easier to twin.

B-33: Emergency spill areas should always be provided near the tailings line in case of power failure etc., in the mill etc. Tailings lines should be self-draining to the tailings area and/or to an emergency spill area. In some cases (i.e., a long line over rough country) several spill areas may have to be provided.

B-34: A mine waste treatment plant should be equipped with an emergency power source. If this is not practicable, retention facilities should be constructed to hold untreated waste until treatment can be provided.

B-35: If practicable, all liquid effluents from a specific property should be directed to a common point (for treatment if necessary) before discharge to a natural watercourse. Treated wastes should not be directed to more than one watershed.

B-36: If practicable, special wastes such as wash water from the reagent storage and mixing area in a flotation mill should be directed to an engineered pond (lagoon) where the concentrated contaminated waste can be held for a period of time in order to permit the decomposition of substances that will break down in a natural environment. The overflow from such a pond could be directed to the tailings area. The pond would act to prevent surges of reagent-rich or oil-rich wastes from entering the tailings area and, as such, would help to protect the mill circuit from upsets due to suddenly impaired recycle water.

B-37: Natural processes (atmospheric oxidation, bacterial activity etc.) should be used to accomplish waste treatment whenever and wherever possible. Mechanical pumping facilities should not be used if gravity flows are possible and practicable.

B-38: In general, sanitary wastes should not be directed to a tailings area without appropriate treatment.

PART C: OPERATION

Guidelines in this section are intended to cover the routine day-to-day activities of an active mine-mill complex.

C-1: A minimum of three feet of freeboard should be maintained in all tailings areas.

C-2: All liquid effluent flows should be subject to routine monitoring.

C-3: All engineered facilities (tailings dams, decant structures etc.) should be inspected on a routine basis for stability etc.

C-4: A tailings slurry should be discharged into a tailings area at a point that is remote from the tailings area decant overflow.

C-5: Domestic garbage and garbage generated by the mine-mill operation itself should not be dumped into watercourses. Instead, approved disposal practices should be followed.

C-6: Revegetation or stabilization of tailings should take place as tailings accumulate during the active life of a mine-mill complex.

PART D: ABANDONMENT

Guidelines in this section are intended to apply to mine-mill properties when they are to be abandoned.

D-1: All mine-mill structures should be completely dismantled. The resulting material should be removed from the property or should be disposed of in a suitable manner.

D-2: All mine-mill machinery etc., should be removed from the property or, if this is not practicable, should be collected and disposed of on the property in a suitable manner. All such waste, for instance, could be collected in a common area and covered with soil (spoil from the pit area etc.). The resulting mound could be easily revegetated. Perhaps this type of

waste could be taken to a gravel pit etc., on the property and, at a suitable time, could be buried. Any small open pits on the property could serve as burial areas.

The possibility of groundwater contamination should always be kept in mind when waste materials are to be buried.

D-3: Whenever and wherever possible and practicable, waste rock or, in general, spoil piles should be graded to below mature tree level. Where this is impossible, waste piles should be kept as low as possible.

D-4: Where garbage from a townsite etc., has been permitted to accumulate, the garbage should be covered with earth and revegetated before the property is abandoned.

D-5: Tailings areas, tailings dams, waste rock dumps, and mill sites etc., should be revegetated in an approved manner.

<u>TAILINGS DISPOSAL</u>

RECOMMENDATIONS

FOR

SITE SELECTION

1979

SUMMARY OF RECOMMENDATIONS

Ontario is a province of abundant land and abundant water. Neither the land nor the water should be abused. However, a mechanism should be available by which both land and water have the potential for intelligent use under a given set of circumstances.

With regard to tailings disposal, dry land tailings disposal schemes generally offer the possibility of maximum environmental control under a given set of conditions. Land-water schemes normally offer a much decreased possibility of control and deepwater schemes, in most cases, offer little possibility of control.

If other than dry land tailings disposal schemes are being considered, the following points should be noted:

A. Deepwater Disposal Schemes

Deepwater tailings disposal schemes involve the direct discharge, at depth, of tailings into a relatively large body of water.

Certain specific restrictions should be placed on the use of deepwater tailings disposal sites:

(i) upon abandonment of the mining operation and/or the tailings disposal site, all deposited tailings should rest considerably below the depth of turbulence caused by surface wave action and should not be in an area subject to scouring by submarine currents.

(ii) the discharge point of a tailings line feeding a deepwater site should be located below the surface of the receiving water and should be below the maximum depth of turbulence caused by surface wave action etc.

(iii) tailings containing mobile coloured slime fractions should not be deposited in deepwater sites.

(iv) tailings containing significant quantities of releasable substances that are regarded as detrimental to human life and/or are regarded as detrimental to aquatic fauna and/or flora should not be deposited in deepwater sites. Such substances

include: ammonia
arsenic
asbestos (chrysotile and/or amphibole)
cadmium
copper
cyanide
lead
mercury
nickel
radioactive materials (e.g., radium, thorium)
toxic organic or inorganic compounds and those organic or inorganic compounds or substances that tend to bio-accumulate.
zinc

B. Land-Water Disposal Schemes

Land-water disposal schemes apply some of the principles of land tailings disposal to a water site. Commonly, a pervious dam is built across a lake or across the mouth of a bay etc., and the area behind the dam is treated as a land disposal site. Normally, as tailings accumulate, the area behind the dam is converted to dry or relatively dry land.

Certain specific restrictions should be placed on the use of land-water tailings disposal sites:

(i) tailings containing significant quantities of releasable substances that are regarded as detrimental to human life and/or are regarded as detrimental to aquatic fauna and/or flora should not be deposited in land-water sites unless:

a) the dam separating the tailings area from the receiving watercourse is impermeable and;

b) the tailings area decant serving the tailings area is directed to a "downstream" facility (preferably on land) for any required chemical and/or physical treatment.

The substances referred to in this item include:
ammonia
arsenic
asbestos (chrysotile and/or amphibole)
cadmium
copper
cyanide

lead
mercury
nickel
radioactive materials (e.g., radium, thorium)
toxic organic or inorganic compounds and those organic or inorganic compounds or substances that tend to bio-accumulate.
zinc.

(ii) tailings containing mobile coloured slime fractions should not be deposited in land-water sites unless effective colour-removal techniques are to be practiced and the general conditions (i)(a) and (i)(b) above have been met;

(iii) the tailings area should be revegetated before being abandoned.

DECANT SYSTEM DESIGN CONSIDERATIONS

FOR

ONTARIO MINING OPERATIONS

1979

INTRODUCTION

The primary function of a tailings area decant system is to convey clarified wastewater from a point within the confines of a tailings area to a point outside of the tailings area. An important but secondary function of a tailings area decant system is to maintain desirable liquid levels within a tailings area.

TYPES OF DECANT SYSTEMS

Many types of decant systems find use in Ontario. The most common system employed involves a vertical decant tower (chimney) which is connected at or near its base to a horizontal (usually slightly inclined) decant tunnel (decant line; decant conduit). The decant tunnel routinely penetrates a tailings dam.

Other decant systems that, at present, find more limited use within the Province include:

(i) mechanical pumps mounted on floating platforms;

(ii) mechanical pumps mounted on fixed bases;

(iii) siphon arrangements and;

(iv) sluice-type overflows.

It is appropriate to emphasize the necessity of integrating the design and operational procedures for decant systems with the design of downstream channels and treatment works which might be overloaded or damaged by excessive flows due to operational or physical failures of the decant system.

DECANT SYSTEM FAILURES

Many tailings dam failures in Ontario have been directly attributed to the failure of a decant system.

Decant system failures can be loosely grouped as:

(a) operational failures, and

(b) physical failures.

(a) Operational Failures

During an operational failure, the decant system involved usually remains intact. The system simply fails to operate in a proper manner.

The two common causes of operational failures are:

(i) plugging, and
(ii) hydraulic overloading.

Plugging of a decant system can happen anytime of the year. During the winter and early spring months, plugging is normally caused by floating blocks of ice that lodge within the decant system itself.

At other times of the year, plugging is usually caused by floating organic litter (logs, branches) and by floating mine-mill waste (oil drums, timber). In some cases, the decant system remains internally free of debris but the entrance to the system becomes blocked.

Hydraulic overloading of a decant system is most likely to occur during the early spring season when excessive quantities of meltwater (derived from accumulations of snow and ice) originate in or gain access to a tailings area over a relatively short period of time. In some cases, however, sudden violent rainstorms of unusual duration have caused decant systems to be hydraulically overloaded.

Whether the operational failure of a decant system is due to plugging or to hydraulic overloading, the end result is the same. If the malfunction is not corrected in time, the tailings area will flood and excess liquid will begin an erosive flow over the tops of the tailings dams. When this condition occurs, tailings dam failure is possible.

(b) Physical Failures

When a decant system physically fails, part or all of the decant system is destroyed. The situation is especially serious when the failure takes place deep within a tailings mass.

Most physical failures of decant systems can be assigned to one or more of three groups of causes:

(i) causes involving mechanical force;

(ii) causes involving chemical or electrochemical corrosion;

(iii) causes involving biological or biochemical factors.

Causes Involving Mechanical Force

During the cold months of the year, large blocks of ice floating in the decant pond can smash repeatedly against unprotected decant structures given the proper conditions. In addition, thick sheets of ice can exert enormous pressures on unprotected structures. Ice build-ups on decant structures can become dangerous due to abnormal buoyancy or weight forces on the structure as decant pond levels are allowed to rise and fall.

During the summer, a decant structure can be damaged when large floating objects such as logs come into repeated contact with the structure.

Decant systems can also be subject to the pressure exerted by overlying water and/or tailings. As the pressure increases due to ever increasing depths of tailings, a poorly designed system can fail.

Abrasion can be another factor in the failure or weakening of a decant system. Abrasion usually results when a tailings area effluent contains abnormal quantities of suspended solids; however, it can also occur when minor quantities of suspended solids in an effluent contact a decant structure over an extended period of time.

Causes Involving Chemical or Electrochemical Corrosion

In many cases, decant facilities are subject to chemical or electrochemical corrosion. This is due to the fact that some mine-mill wastewaters are quite acid (pH less than 4.0) or quite alkaline (pH greater than 8.0). When an acid or an alkaline condition prevails, a variety of materials that find common use in decant construction can either be weakened or destroyed.

Causes Involving Biological or Biochemical Factors

Biological or biochemical factors are normally involved in the deterioration (rotting) of wooden decant structures. In addition, certain types of bacteria are known to produce substances such as acids as a result of their activities and these substances have the ability, in many cases, to weaken or destroy commonly used structural materials.

GENERAL DECANT SYSTEM DESIGN GUIDELINES

The following decant design considerations are intended to apply to the decant tower: decant tunnel type of system:

(1) A decant system should be sited on a secure foundation. Whenever possible, a decant tower should be sited on bedrock.

Where a decant tower cannot be sited on bedrock, the foundation chosen must be strong enough in the long term to prevent settling.

(2) Decant systems should be engineered to adequately withstand adverse chemical and/or physical stresses.

(3) A decant system should be hydraulically sized to accept 150 per cent of the maximum waste flow expected from the active tailings area being served during a one-in-ten-year storm. However, in instances where failure involves possible major structural damage or risk to human lives, rarer occurrences such as a one-in-fifty or one-in-one hundred year storm should be used as a basis of design.

(4) The intake of a decant system should be located as far away as possible from the point of tailings discharge to the tailings area in order to avoid an overflow that is contaminated with suspended solids.

(5) The intake of a decant tower should not be so close to a dam as to cause swirling currents or eddies near the dam face unless suitable protection is provided for the dam face.

(6) Access to the intake (or entrance) of a decant facility should be suitably provided.

(7) All decant system intakes should be equipped with trash (litter) screens in order to avoid plugging of the system by debris.

Trash screens are susceptible to plugging and therefore should be inspected and cleaned regularly.

(8) When and where practicable, a decant system intake should be equipped with a rugged baffle in order to prevent oil and other finely divided floating debris from gaining access to downstream areas.

(9) A decant system should be equipped with an adjustable intake so that the flow through the system can be varied or eliminated if necessary.

(10) A decant system should be designed to permit easy clean-out of the system should it become plugged.

(11) Decant tunnels (within a tailings mass) should be kept as short as practicable.

(12) Consideration should always be given to alternate decant methods (such as the emergency use of siphons or spillways) should the main decant structure fail.

(13) Within a tailings berm itself, a decant tunnel (pipe) should be equipped with several seepage rings in order to prevent the erosive migration of water along the outside of the tunnel (pipe) and ultimate dam failure.

(14) Routine inspection of all active decant systems should be required.

(15) Upon abandonment of a particular decant facility, the decant tunnel and decant tower should be plugged. Surface drainage from abandoned areas should be routed from the areas via cuts through bedrock and via adequately designed and protected spillways.